Biological Characteristics of the Sport Harvest of Pacific Halibut in Southcentral Alaska, 1992

by

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BIOLOGICAL CHARACTERISTICS OF THE SPORT HARVEST
OF PACIFIC HALIBUT IN SOUTHCENTRAL ALASKA, 1992[1]

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ABSTRACT

Age, length, and sex data were collected from 4,377 halibut *Hippoglossus stenolepis* landed by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992. Harvested halibut were 3-22 years old and were fully recruited to the sport fishery by ages 8 or 9. Ninety-eight percent of the harvested fish were 50-150 centimeters long. Mean weights (net) ranged from 7.2 kilograms (15.9 pounds) at Seward to 12.3 kilograms (27.1 pounds) at Kodiak. Age composition was significantly different among months only at Homer, while length composition differed among months at Homer, Seward, and Valdez. Female halibut made up 63% of the harvest at Seward, and 80%-85% of the harvest at other ports. Differences in age and size among ports corresponded with differences in sex composition. Halibut caught by chartered anglers at Homer and Seward were significantly longer than fish caught by private or military charter anglers. Geographic differences in size composition, sex composition, and length-at-age suggest there may be substocks of halibut that are subject to varying levels of exploitation.

KEY WORDS: Pacific halibut, *Hippoglossus stenolepis*, Kodiak, Homer, Seward, Valdez, Alaska, Gulf of Alaska, Prince William Sound, Cook Inlet, Kachemak Bay, Resurrection Bay, Chiniak Bay, sport fishery, harvest, species composition, age, length, weight, growth.

INTRODUCTION

Participation in marine sport fisheries in Southcentral Alaska has grown dramatically. Sport fishing effort for all species in marine waters between Cape Spencer and Kodiak Island (Figure 1) increased steadily from 203,933 angler-days in 1979 to 435,873 angler-days in 1991 (Appendix A1; Mills 1981a-1992). Coastal waters of Cook Inlet, including Kachemak Bay, accounted for over half of the effort in most years (Figure 2). This effort typically represented about half of the statewide effort for all marine finfish. Kodiak, Homer, Deep Creek, Seward, and Valdez are the major ports of recreational fish landings (Figure 1).

Pacific halibut *Hippoglossus stenolepis* (halibut hereafter) is a major species of interest in Southcentral Alaska sport fisheries. For purposes of this report, Southcentral Alaska is defined as International Pacific Halibut Commission (IPHC) Regulatory Area 3A, extending roughly from Cape Spencer westward to Cape Trinity on the southern end of Kodiak Island. Recreational harvests in Area 3A rose steadily from 17,840 fish in 1977 to 189,398 fish in 1991 and represented 59%-84% of the Alaska statewide harvest during this period (Figure 3; Appendix A2; Mills 1979-1992). Halibut appear to be increasing in popularity with sport anglers; the proportion of the Area 3A finfish harvest made up of halibut increased from 33% (in number) in 1987 to nearly 45% in 1991 (Mills 1988-1992).

The recreational halibut fishery is important to the economy of Southcentral Alaska. In 1986, sport anglers spent $18.6 million in pursuit of halibut in Southcentral Alaska (excluding the Kodiak archipelago; Jones and Stokes 1987). In addition, they indicated a willingness to pay an additional $25.2 million to ensure the availability of halibut fishing opportunities. Most port communities sponsor halibut derbies that offer lucrative prizes to attract anglers. This fishery also supports a growing charter boat industry. Five hundred forty-six vessels from ports in Area 3A were licensed by the IPHC for sport charter fishing in 1992[1] (C. Blood, IPHC, personal communication). Chartered anglers accounted for about one-half of the 1991 sport harvest at Seward and in lower Cook Inlet (Figure 4), and catch rates from charter boats can be as much as five times higher than from private boats (Roth and Delaney 1989).

Area 3A is the major area of recreational halibut landings coastwide. The 1991 estimated recreational harvest of 3.75 million pounds (eviscerated, head off) from Area 3A made up over 60% of the coast-wide sport harvest (Sullivan 1992). Although the recreational fishery is growing, it only accounted for 11% of the total halibut removals in Area 3A in 1991. Other removals (in millions of pounds) included: 23.60 commercial harvest (68%), 5.00 bycatch in other fisheries (14%), 1.54 wastage (4%), and 0.96 subsistence (3%). Wastage included mortality of sublegal size halibut and fish killed by lost or abandoned gear. Directed commercial harvest, bycatch in other commercial fisheries, and wastage accounted for 86% of all removals (Patrick Sullivan, IPHC, personal communication).

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[1] This figure represents the approximate number of vessels legally capable of conducting sport charters; not all vessels registered in Area 3A operated in Area 3A, and not all licensed vessels actually conducted sport charters.
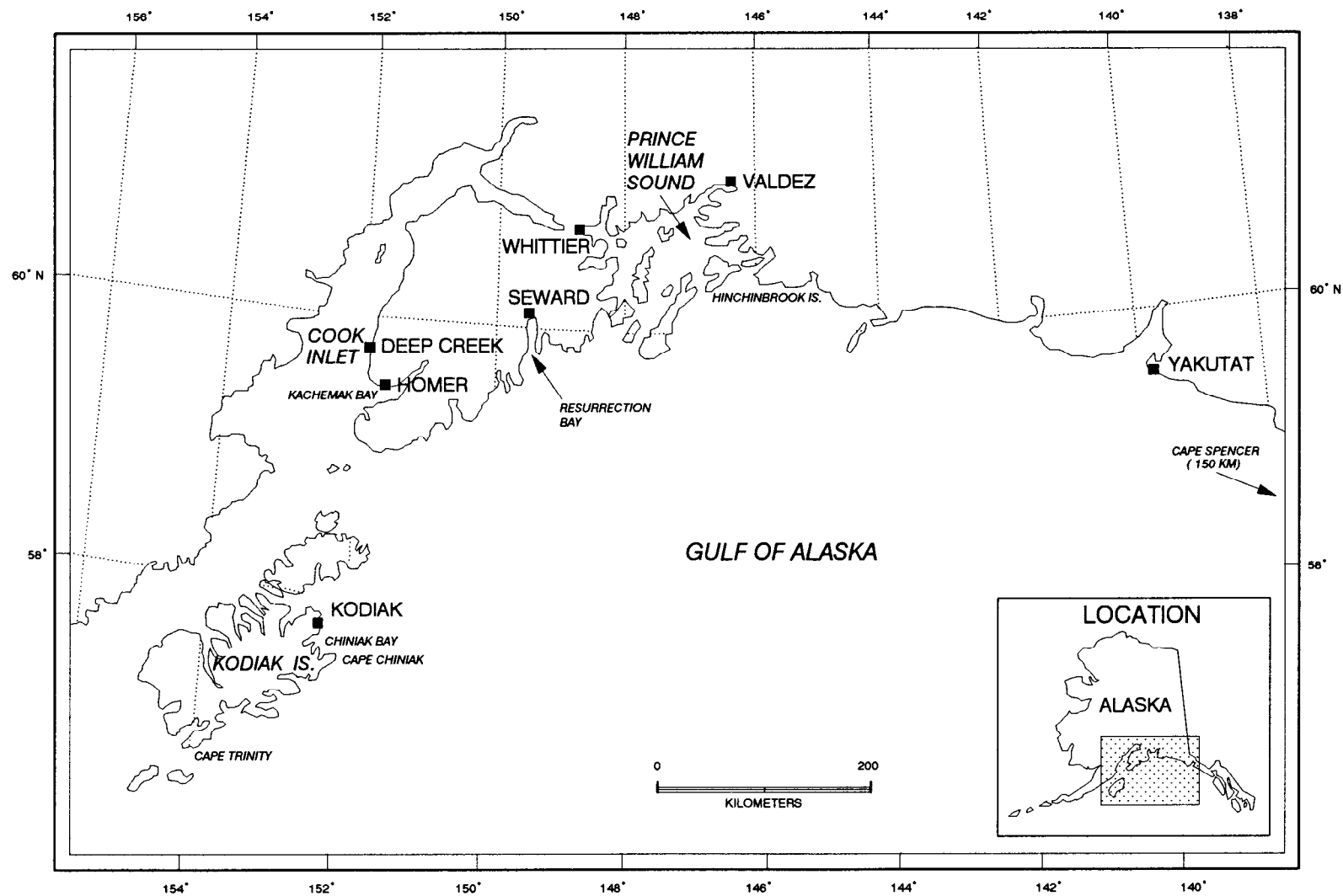
Figure 1. Southcentral Alaska coastal waters and major ports of recreational halibut landings.
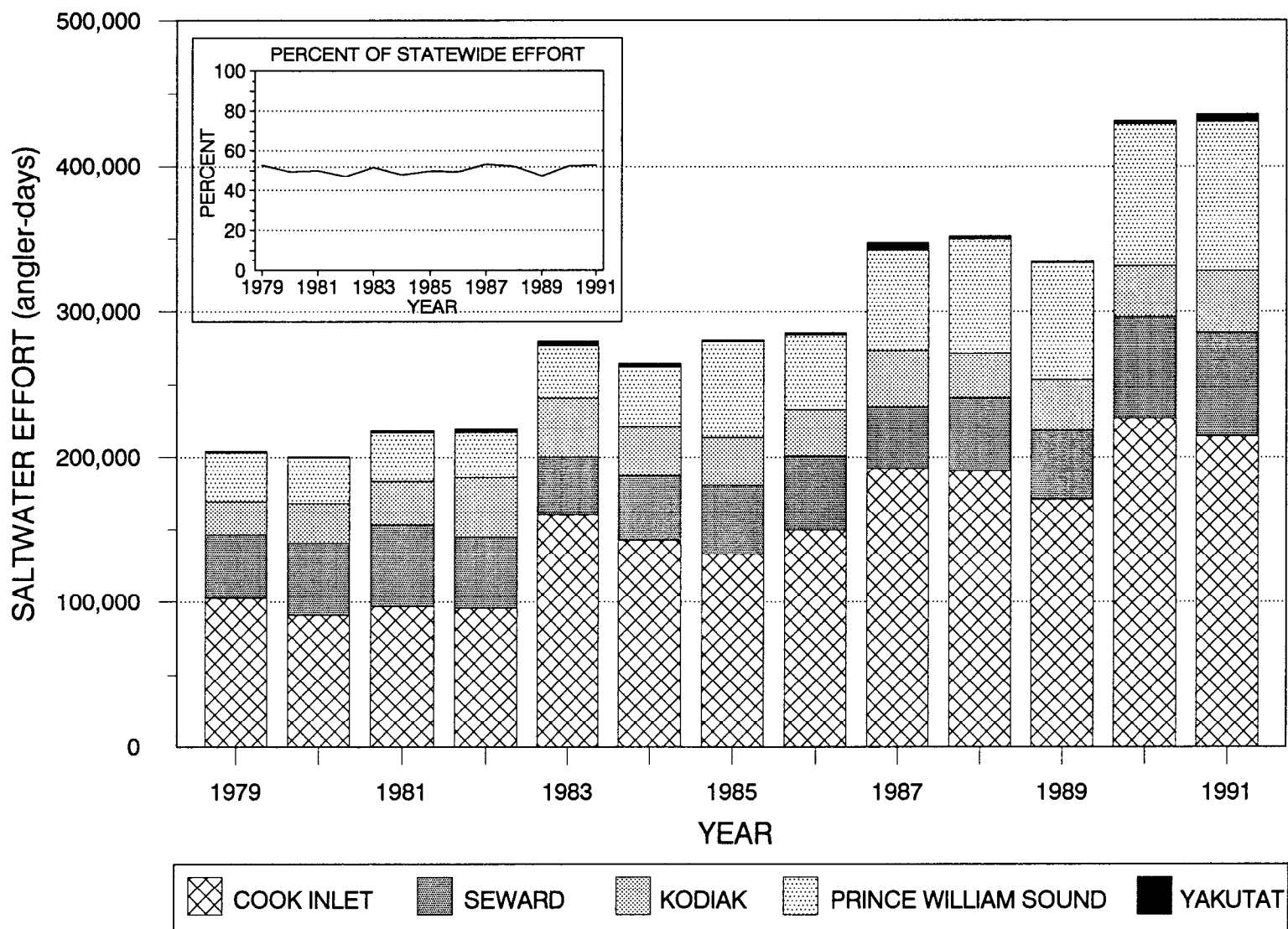
Figure 2. Estimated angler effort, by region, for all finfish in marine waters of Southcentral Alaska (IPHC Regulatory Area 3A), 1979-1991 (Mills 1981a-1992). Over this same period, about 50% of the annual statewide effort for marine finfish was expended in Area 3A (inset).
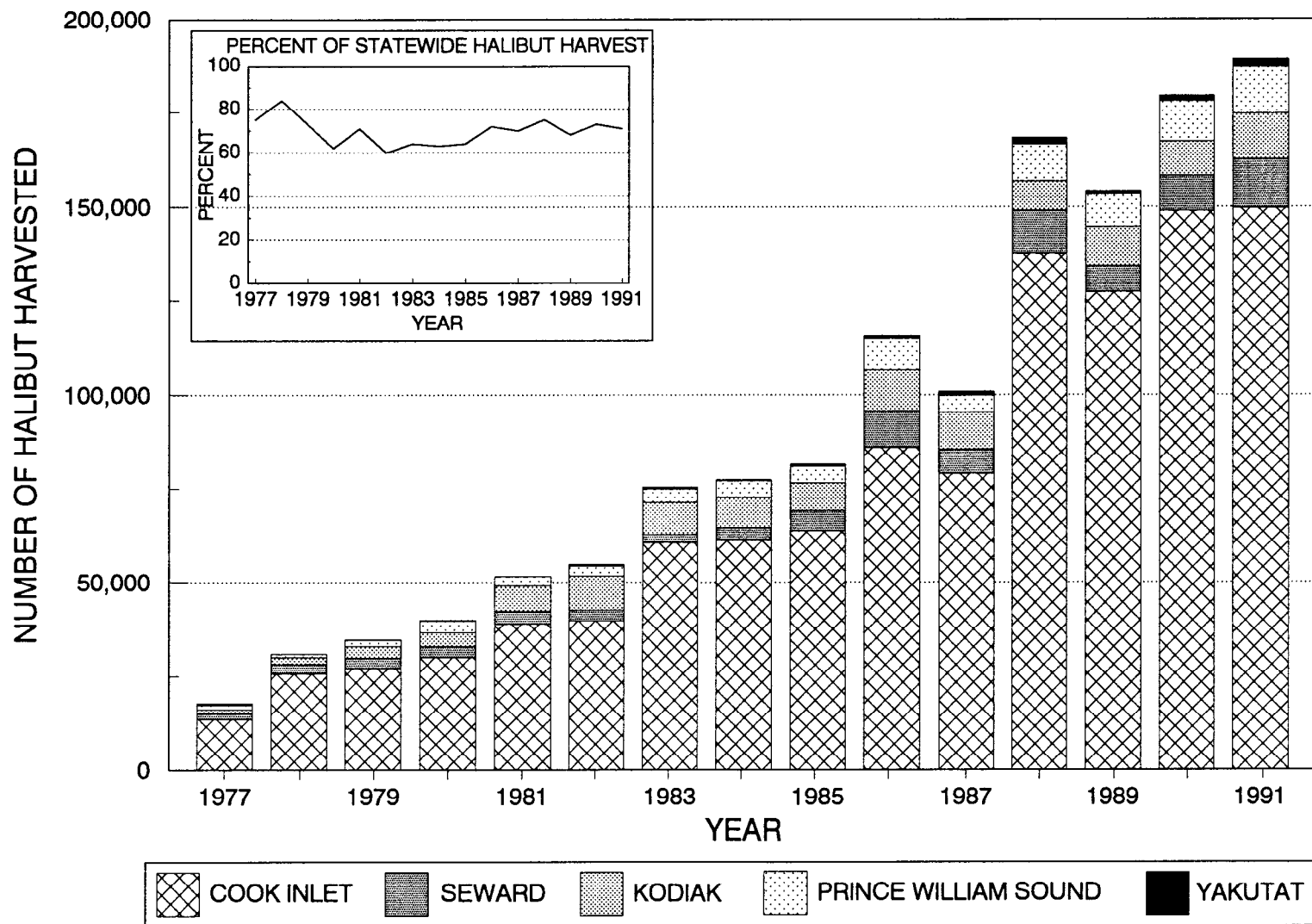
Figure 3. Estimated sport harvest of halibut, by region, in IPHC Regulatory Area 3A, 1977-1991 (Mills 1979-1992). About 60%-84% of the statewide halibut harvest has come from Area 3A (inset).
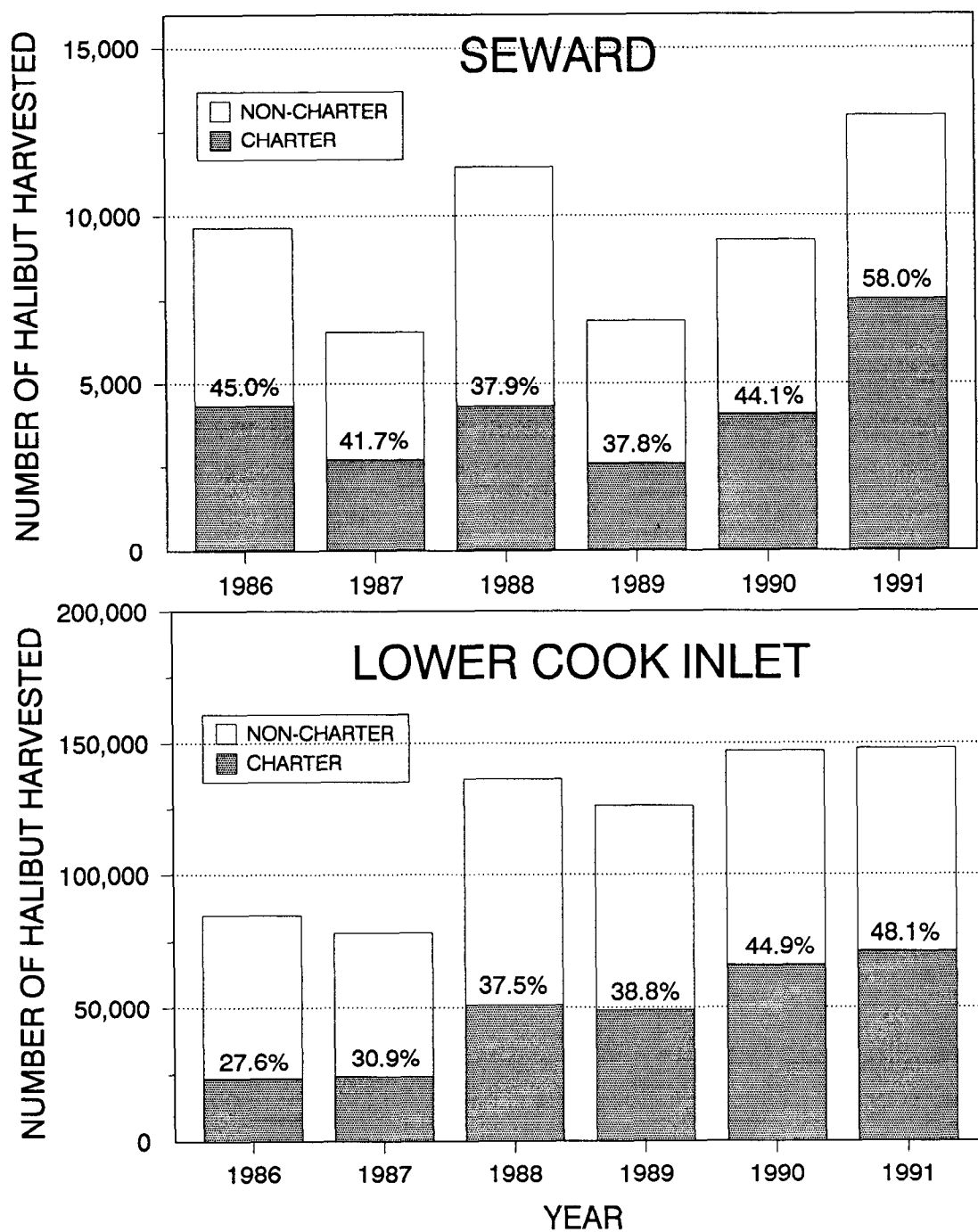
Figure 4. Percentages of the sport harvest of halibut taken by chartered and non-chartered anglers at Seward and in lower Cook Inlet fisheries (Homer, Deep Creek, Whiskey Gulch, etc.), 1986-1991 (Mills 1987-1992).

As sport harvests are increasing, the estimated biomass of halibut in Area 3A is declining (Figure 5). The stock is expected to continue declining at a rate of about 5%-10% per year over the next several years, but should stabilize soon because of increased recruitment (Sullivan 1992). Decreasing biomass may be reflected in the recent decrease in sport catch (fish killed plus fish released) in Area 3A. Anglers released only 32% of the 277,402 halibut they caught in 1991, compared with over 46% of the 334,931 fish caught in 1990 (Table 1). As sport harvests grow in the face of decreasing stock biomass, the sport harvest will continue to make up an increasingly larger share of the total harvest.

The IPHC has monitored and managed halibut in the north Pacific Ocean since 1924 (IPHC 1987). The IPHC sets fishing quotas based on estimates of exploitable stock biomass obtained using catch-at-age data. Historically, only commercial removals were used in the estimation of biomass, and sport harvest and wastage were assumed to occur at a constant rate. Recent increasing trends in recreational harvests have prompted the IPHC to account for all additional sources of removal, including sport, subsistence, bycatch, and wastage. Incorporation of sport harvest in the 1991 assessment led to a 10%-15% increase in overall harvest and a 10% increase in estimated biomass over recent years (Sullivan et al. 1992). As sport harvests continue to rise, the IPHC has expressed keen interest in obtaining age, size, sex, and catch rate information from recreational fisheries coast-wide (R. Trumble, IPHC, personal communication).

Although halibut are economically important and growing in popularity, limited information has been collected from the Southcentral Alaska sport fishery. Prior studies by the Alaska Department of Fish and Game, Division of Sport Fish (ADF&G) included creel surveys at Seward in 1987, 1988, and 1989 (Vincent-Lang et al. 1988; Carlon and Vincent-Lang 1989, 1990; Vincent-Lang 1991) and at Valdez in 1988 (Roth and Delaney 1989). Limited age and size data were collected at Seward in 1988, 1989, and 1990 (Vincent-Lang 1991), at Homer and Deep Creek in 1988, and at Valdez in 1990.

In 1991 the ADF&G began a long-term port sampling study to collect basic biological data from groundfishes harvested in recreational fisheries throughout Southcentral Alaska. Although the project was initiated largely out of concern for rockfishes *Sebastes* and lingcod *Ophiodon elongatus*, it afforded the opportunity to gather corresponding halibut data. Studies in 1992 focused on the major ports of recreational groundfish landings: Kodiak, Homer, Seward, and Valdez. The overall goal of the project is to provide information necessary for the management of recreational groundfish fisheries. With respect to halibut in Area 3A, the objectives were to estimate:

    1. age composition,

    2. length composition, and

    3. sex composition of halibut harvested at each port each month.

Monthly estimates allowed examination of seasonal trends in age, length, and sex composition before pooling to obtain overall estimates for the entire season. In addition to the formal objectives above, three additional tasks were identified:
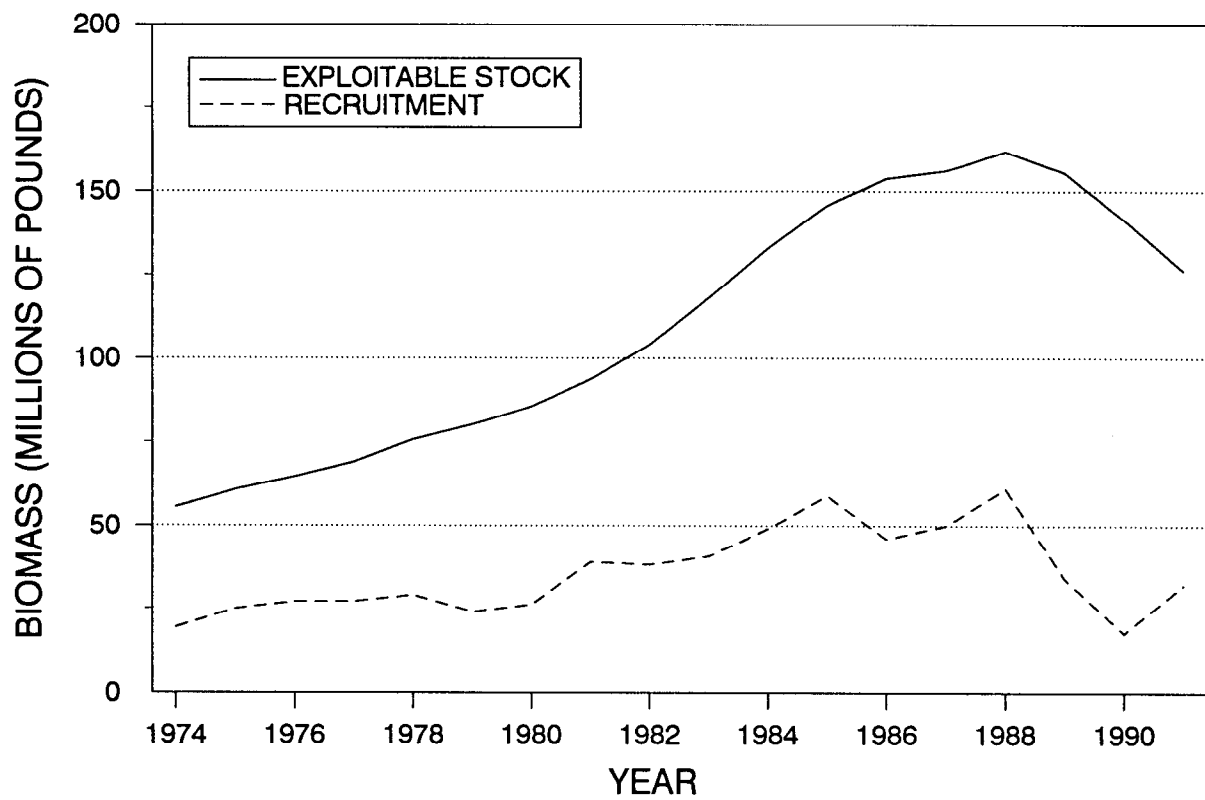
Figure 5. Estimated exploitable stock biomass and recruitment of halibut in
Area 3A, 1974-1991 (Sullivan 1992).

Table 1. Estimated proportions of halibut released by sport anglers in Southcentral Alaska in 1990 and 1991 (Mills 1991, 1992).

Location	1990				1991		
	Catch (Number)	Harvest (Number)	Percent Released		Catch (Number)	Harvest (Number)	Percent Released
Cook Inlet[a]	281,195	148,760	47.1		222,010	149,503	32.7
Seward[b]	15,941	9,278	41.8		16,299	12,961	20.4
Kodiak[c]	16,846	9,134	45.8		18,757	12,089	35.5
Prince William Sound[d]	18,897	10,851	42.6		17,769	12,733	28.3
Yakutat[e]	2,052	1,459	28.9		2,567	2,112	17.7
TOTAL	334,931	179,482	46.4		277,402	189,398	31.7

[a] Cook Inlet: waters north of a line roughly from Gore Point to Cape Douglas.

[b] Seward: waters of Resurrection Bay and the southern coast of the Kenai Peninsula.

[c] Kodiak: marine waters surrounding the Kodiak and Afognak Island groups, including the Barren and Trinity Islands.

[d] Prince William Sound: waters between Cape Suckling and Cape Puget.

[e] Yakutat: Yakutat Bay and adjacent Gulf of Alaska waters.

1. estimate the mean weight of halibut harvested at each port,

2. estimate the mean length-at-age of all harvested halibut, and

3. test the hypothesis that there is no difference in size composition between charter-caught and private-caught halibut at each port.

The first two tasks addressed specific requests of the IPHC, and the third was undertaken to provide information for designing future surveys.

METHODS

Study Design

Technicians were stationed at Kodiak, Homer, Seward, and Valdez. These locations were chosen to provide representative data on halibut harvested from Prince William Sound, Cook Inlet, Kachemak Bay, and the nearshore waters of the Gulf of Alaska between Hinchinbrook Island and Cape Chiniak on Kodiak Island (Figure 1). Kodiak was sampled at St. Paul's Harbor and St. Herman's Harbor. All samples at Homer were from fish landed in the Homer Spit boat harbor. Locations sampled at Seward included the boat harbor and the fish cleaning buildings at the U.S. Army and U.S. Air Force recreation camps. The main boat harbor was sampled at Valdez.

Sampling was conducted for an average of 7.0 hours per day, 5 days per week (including all weekends) at all ports. The hours sampled varied by port and by day in response to weather and other variables, but generally included the period 1500-2200 hours when most anglers return to port. Technicians intercepted cleaned fish carcasses at fish cleaning stations in the boat harbors and at charter operator offices. Designated barrels were placed near the cleaning stations or boat ramps to collect fish carcasses when the technician was busy or off-duty. Signs were posted in each harbor explaining the sampling program and requesting angler cooperation.

Sampling was designed to be proportional to harvest within each month at each port. With few exceptions, all halibut seen during the work shift were sampled at Kodiak. At Homer, Seward, and Valdez, there were often too many halibut landed to sample every fish each day. In addition, harvest varied widely by day and by month. To accommodate the variable harvest and avoid sampling bias, halibut were sampled systematically (e.g. every 3rd fish). The sampling fraction was adjusted each month at each site so that (with rare exception) technicians would be able to draw each day's sample from the entire pool of fish available during a work shift. Homer and Seward required more frequent adjustment of sampling rates because of unexpected variation in harvest. The sampling rate was applied to all sublocations from which fish were obtained at each port so that private, charter, and military components were sampled proportionately.

All halibut were measured to the nearest 5 mm in a straight-line distance from the tip of the snout to the tip of the center lobe of the tail. Sex was determined by inspection of gonads. Otoliths (saggitae) were removed and cleared in glycerin and water. Whole left otoliths were aged under a dissecting microscope (Chilton and Beamish 1982). In order to minimize

between-year drift in ageing, the reader read a subset of 105 otoliths collected in 1991 prior to reading otoliths from 1992. To help ensure parity with ageing by the IPHC, another subset of 113 otoliths collected in 1992 was sent to the IPHC for assessment of between-reader differences.

Data Analysis

It was desired to estimate the proportional contribution of each age, length, and sex class to within 10% of the true proportion at least 95% of the time. A minimum of 128 samples was needed to meet this goal (Thompson 1987). Because many more otoliths were collected than necessary, subsamples of approximately 150 otoliths from the central dates of each month were aged. The proportional contribution of each age class to the sport harvest each month (Objective 1) was estimated as (Cochran 1977):

$$\hat{p}_{ij} = \frac{n_{ij}}{n_j} , \qquad (1)$$

where:

$\hat{p}_{ij}$ = the estimated proportion of age class i in the harvest in month j,

n_{ij} = the number of fish of age i sampled in month j, and

n_j = the number of fish of all ages sampled in month j.

The unbiased estimator of the variance of each proportion was

$$Var(\hat{p}_{ij}) = \frac{\hat{p}_{ij} (1 - \hat{p}_{ij})}{n_j - 1} . \qquad (2)$$

The finite population correction (FPC) to the estimated variance (Cochran 1977) was ignored because sample size was small relative to the harvest and the harvest was unknown. Estimates of variance were therefore conservative (only slightly larger than if harvest were known). Length and sex composition were computed using the above equations by substituting length and sex for age (Objectives 2 and 3).

Differences in age and sex composition between months and between sites were tested using chi-square contingency tables (Conover 1980). Age classes near the tails of the age distributions were pooled so that chi-square statistics were made up mostly of differences in the primary age classes. Differences in length composition between sites and months were tested using k-sample Anderson-Darling tests (Scholz and Stephens 1987) employing the test statistic T_{akn} to determine probabilities. Monthly data were pooled to obtain age, length, and sex composition for the entire season at each site using equations 1 and 2.

When differences in age, length, or sex composition between months were statistically significant ($P < 0.05$), the monthly estimates were weighted to compute composition for the entire season (Cochran 1977; page 91). Monthly

estimates were weighted by the estimated fraction of the total harvest that occurred each month. This fraction was obtained by expanding monthly sample sizes by the sampling rate. None of the weighted estimates of age, length, or sex composition were significantly different ($\alpha = 0.05$) than unweighted estimates. Given the insignificant changes due to weighting and the unknown bias in estimating the fraction of the harvest that occurred each month, all final estimates are unweighted.

Because most measurements were from cleaned carcasses, the number of fish weighed was inadequate to estimate the mean weight of halibut harvested at each port (Task 1). Therefore, mean weight was computed as the arithmetic mean of predicted weights of all sampled fish (Nielsen and Schoch 1980). The weight of individual fish was predicted by

$$\hat{W} = aL^b, \tag{3}$$

where:

$\hat{W}$ = the predicted weight in pounds,

L = the observed length in centimeters,

a = 6.921 X 10^{-6} for net weight (eviscerated, head off), and 9.205 X 10^{-6} for round weight (Clark 1992), and

b = 3.24 (Clark 1992).

Mean weights were presented in pounds because that is the standard unit used by the IPHC. Variance of mean weights were estimated using standard normal procedures (Cochran 1977; page 26) substituting predicted for observed weights, and are therefore minimum estimates.

Mean length-at-age was computed separately for males and females harvested during July (Task 2). Only data from July were used to avoid within-season growth effects. Because there were apparent differences in length-at-age between ports, the overall estimates of mean length-at-age were weighted by the estimated fraction of each sex and age group that were harvested at each port. These fractions were computed by expanding the July sample sizes by the sampling rate as described above. For each sex and age group, the mean length-at-age was estimated using

$$\bar{L} = \sum_{k=1}^{4} (h_k/h) \, l_k, \tag{4}$$

where:

$\bar{L}$ = the mean length of a sex and age group harvested at all ports,

h_k = the observed harvest (number) of a sex and age group at port k,

h = the total observed harvest of a sex and age group at all ports, and

l_k = the mean length of a sex and age group harvested at port k.

The minimum variance of each weighted mean length-at-age was estimated by:

$$Var(\bar{L}) = \sum_{k=1}^{4} (h_k/h)^2 \, Var(l_k), \qquad (5)$$

where $Var(l_k)$ is the estimated variance of mean length-at-age at each port. These are minimum variance estimates because the error in estimating the weighting factors (h_k/h) was unknown (i.e. treated as a constant).

Differences in length composition between charter and sport-caught halibut (Task 3) were tested using k-sample Anderson-Darling tests as described above.

RESULTS

Sampling in 1992 was conducted from late May through mid-September. Startup and ending dates varied because of differences in effort as well as hiring and logistical constraints. Dates sampled at each port were as follows:

Kodiak	June 4	September 7
Homer	May 16	September 11
Seward	May 16	September 13
Valdez	June 1	September 7

Data were collected from 4,377 halibut in 1992 (Table 2). The largest sample sizes were obtained at Homer (1,694), the primary port of recreational halibut landings coastwide. Systematic sampling rates were inversely related to the harvest of halibut and other fishes. June and July were the months of greatest observed harvest at all ports (Table 2).

Age Composition

A total of 2,337 otoliths were aged: 476 from Kodiak, 760 from Homer, 638 from Seward, and 463 from Valdez. Fish ranged from 3 to 22 years old, but 95% were between 5 and 13 years. Modal ages varied by location and month but were generally ages 8 or 9 (Appendix B). Ages assigned by ADF&G and IPHC readers compared favorably. Of 113 otoliths read by both agencies, 55% of the assigned ages were in agreement, and 87% were within one year. Differences were distributed symmetrically, and the resulting age distributions were not significantly different ($\chi^2 = 2.681$, $P = 0.913$, df = 7).

There was no significant difference in age composition of the sport harvest among months at Kodiak ($\chi^2 = 12.175$, $P = 0.144$, df = 8), Seward ($\chi^2 = 22.690$, $P = 0.122$, df = 16), or Valdez ($\chi^2 = 12.104$, $P = 0.147$, df = 8). There was a difference among months at Homer ($\chi^2 = 79.224$, $P < 0.001$, df = 16), where younger fish made up an increasingly large proportion of the harvest in August and September.

Overall age compositions for the season were functionally similar between Kodiak, Seward, and Valdez, with modes at age 8 and similar proportions of fully recruited fish (Figure 6). Halibut harvested at Homer were slightly older, with a mode at age 9 and relatively fewer fish in age classes 5-8. Differences between all ports were statistically significant ($\chi^2 = 97.809$,

Table 2. Systematic sampling rates and proportions of the observed halibut harvest sampled from Area 3A sport fisheries in 1992.

Port	Period	Sampling Rate	Number Sampled	Number Observed[a]	Proportion Observed by Month[b]
Kodiak	Jun	1/1	241	241	0.358
	Jul	1/1	244	244	0.362
	Aug	1/1	182	182	0.270
	Sep	1/1	7	7	0.010
	Total		674	674	1.000
Homer	May 16-30	1/10	260	2,600	0.069
	Jun 1-20	1/10	549	5,490	0.146
	Jun 21-30	1/50	128	6,400	0.170
	Jul	1/50	293	14,650	0.389
	Aug	1/25	323	8,075	0.215
	Sep	1/3	141	423	0.011
	Total		1,694	37,638	1.000
Seward	May 16-23	1/1	208	208	0.029
	May 24-31	1/5	104	520	0.073
	Jun	1/10	256	2,560	0.360
	Jul	1/10	271	2,710	0.381
	Aug 1-20	1/10	86	860	0.121
	Aug 21-31	1/5	40	200	0.028
	Sep	1/1	53	53	0.007
	Total		1,018	7,111	1.000
Valdez	Jun	1/2	488	976	0.401
	Jul	1/4	229	916	0.375
	Aug	1/2	242	484	0.198
	Sep	1/2	32	64	0.026
	Total		991	2,440	1.000

[a] Obtained by expanding the sample size by the sampling rate. This was total number of fish encountered by the sampler during work shifts.

[b] These proportions represent the approximate fraction of the total harvest that occurred each month.
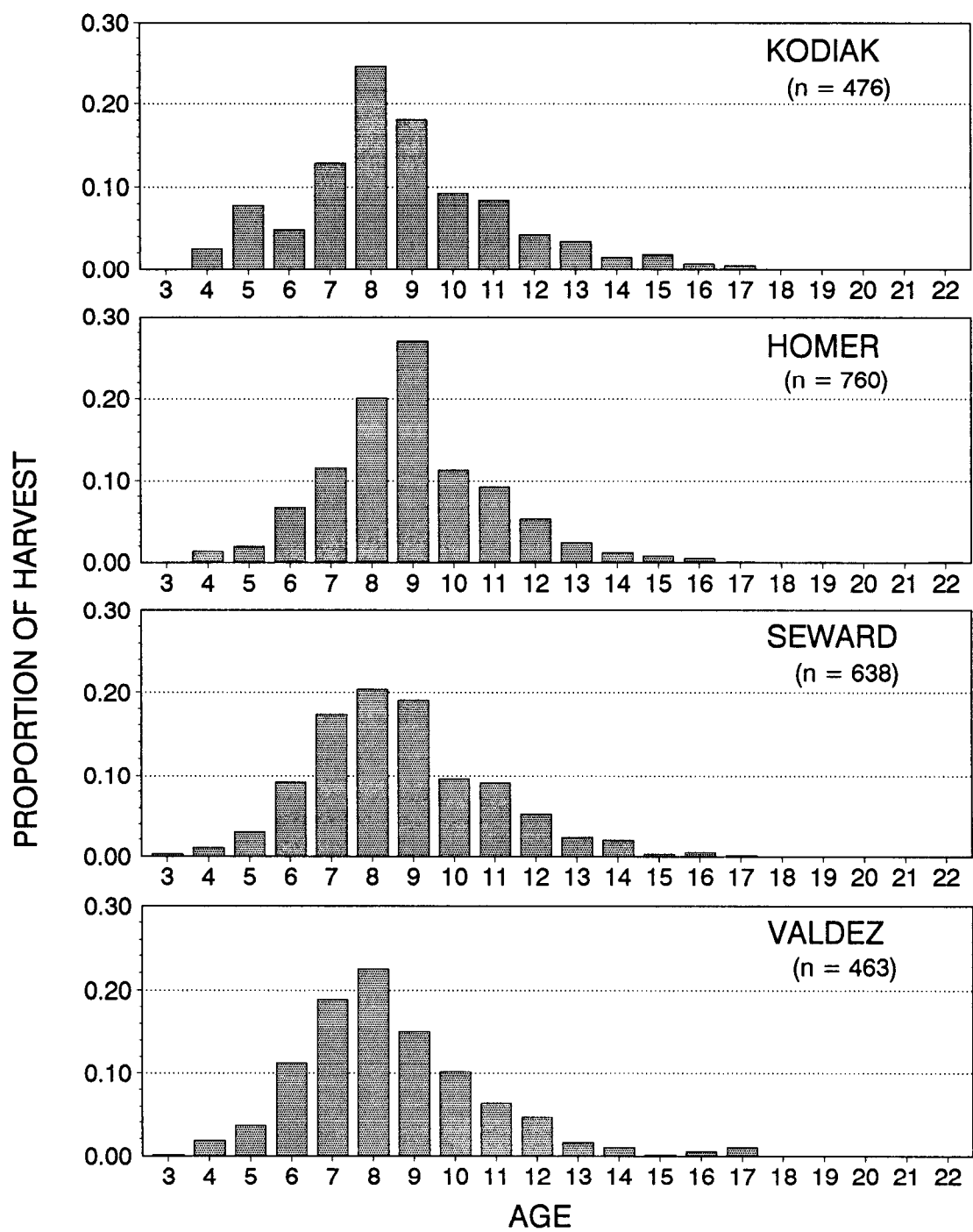
Figure 6. Age composition of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

P < 0.001, df = 27). Although age distributions of fish harvested at Kodiak, Seward, and Valdez appeared similar, differences were statistically significant (χ^2 = 45.968, P < 0.001, df = 18). Because sample sizes were large and there were many age groups, chi-square tests may have detected differences that were of little functional importance.

Length and Weight

Length and Weight Summary Statistics:

Length measurements were obtained from 4,303 halibut. Lengths ranged from 34.0 cm to 217.5 cm (Table 3) but 98% were between 50 cm and 150 cm in length. Estimated mean round weights of harvested fish ranged from 21 pounds at Seward to 36 pounds at Kodiak. Corresponding mean net weights ranged from 16 to 27 pounds. On average, halibut harvested at Kodiak were longer and heavier than other sites.

Length Composition:

There were significant differences in length composition among months at Homer (T_{akn} = 15.889, P < 0.001, m = 4), Seward (T_{akn} = 2.324, P = 0.029, m = 4), and Valdez (T_{akn} = 3.085, P = 0.012, m = 3). Monthly changes in length composition were most pronounced at Homer and Valdez, with the smallest fish taken in September (Figure 7, top). The difference observed at Seward was largely due to the higher proportion of halibut over 80 cm taken in May. Monthly differences in length composition were not significant at Kodiak (T_{akn} = 0.129, P = 0.344, m = 2).

Overall estimates of length composition were obtained by pooling monthly samples. Halibut harvested at Seward were considerably smaller than all other ports (Figure 7, bottom). Homer had the smallest proportion of fish under 80 cm, and Kodiak and Valdez had the highest proportions of fish over 90 cm. Differences among ports in length composition were significant (T_{akn} = 95.280, P < 0.001, m = 3).

Tests for differences in length composition of charter-caught and private-caught halibut were done for Homer and Seward only. The numbers of fish that could be positively identified as private-caught were insufficient at Kodiak and Valdez. The private boat harvest at Homer contained more fish under 90 cm than the charter boat harvest (Figure 8A), and differences between groups were significant (T_{akn} = 10.673, P < 0.001, m = 1). Four user groups were defined at Seward: private, public charter, U.S. Air Force charter, and U.S. Army charter. Halibut harvested by public chartered anglers were significantly larger (T_{akn} = 23.100, P < 0.001, m = 3) than fish taken by the other three groups (Figure 8B).

Mean Length-at-Age:

Mean length-at-age was estimated for all halibut of known sex collected in July. As expected, females were larger at age than males (Table 4). Mean lengths-at-age were weighted by the harvest at each port because simple plots of mean length-at-age suggested that there may have been differences between some ports (Figure 9; Appendix B3). Fish of both sexes landed at Seward appeared smaller at most ages, while females from Kodiak appeared larger at

Table 3.   Length,   net   weight   (eviscerated,   head   off),   and   round
           weight statistics for halibut harvested in the sport fisheries at
           Kodiak, Homer, Seward, and Valdez in 1992.   Net and round weights
           were estimated   from   observed   lengths   using   length-weight
           relationships (Clark 1992).

	Port	Sample Size	Range	Mean	SE(Mean)
Length (cm):					
	Kodiak	662	43.8 - 206.3	99.12	1.12
	Homer	1,673	44.0 - 217.5	92.84	0.51
	Seward	999	41.5 - 198.5	85.39	0.68
	Valdez	969	34.0 - 210.2	95.37	0.86
Net Weight (lbs):					
	Kodiak	662	1.44 - 218.35	27.11	1.11
	Homer	1,673	1.46 - 259.14	19.87	0.51
	Seward	999	1.21 - 192.71	15.89	0.56
	Valdez	969	0.63 - 232.01	23.61	0.83
Round Weight (lbs):					
	Kodiak	662	1.92 - 290.40	36.05	1.47
	Homer	1,673	1.95 - 344.66	26.43	0.67
	Seward	999	1.61 - 256.31	21.14	0.74
	Valdez	969	0.84 - 308.57	31.40	1.10
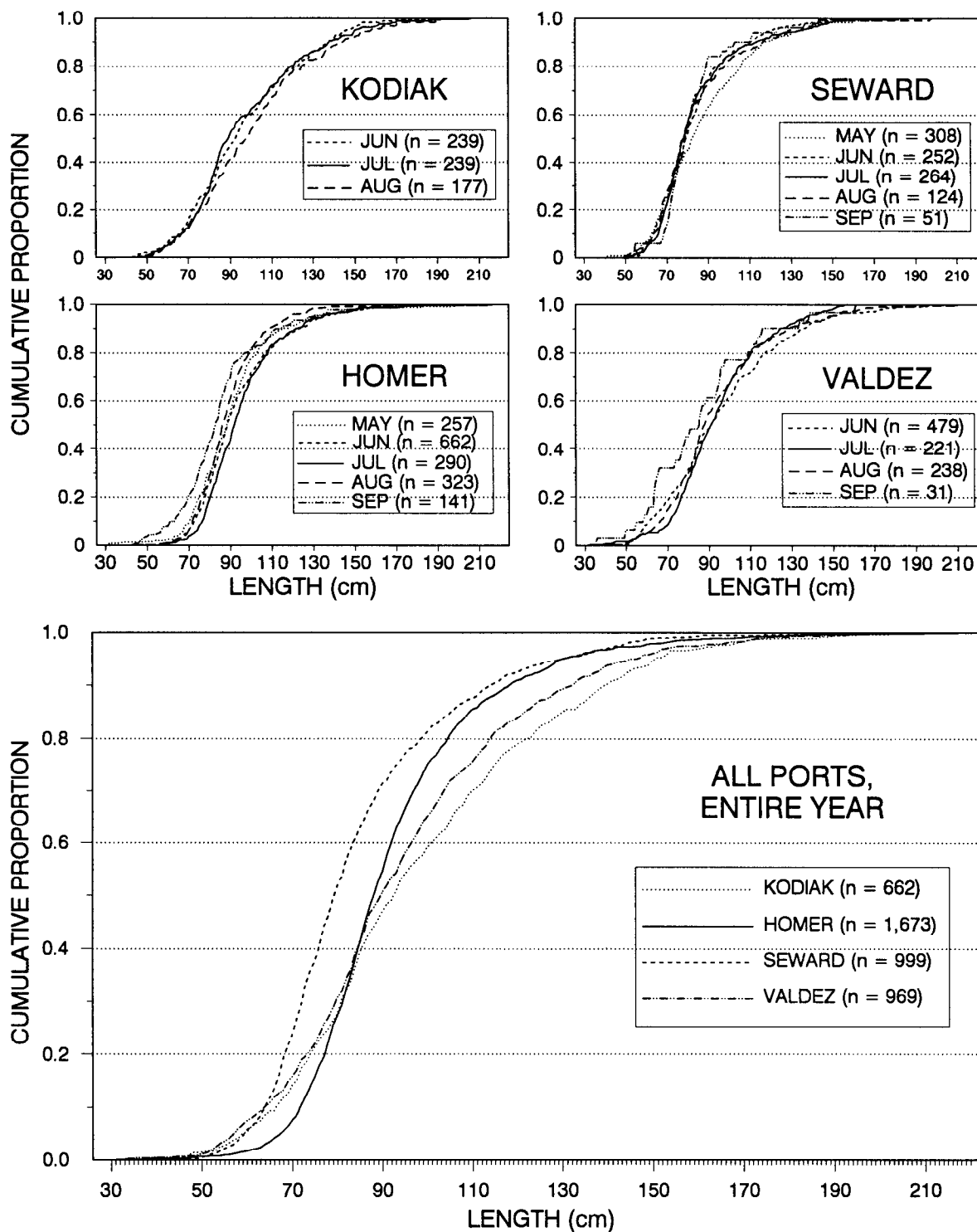
Figure 7. Cumulative length-frequency distributions of halibut harvested at Kodiak, Homer, Seward, and Valdez in 1992. Upper graphs show seasonal differences by port, and the lower graph shows overall length composition at each port (n = sample size).
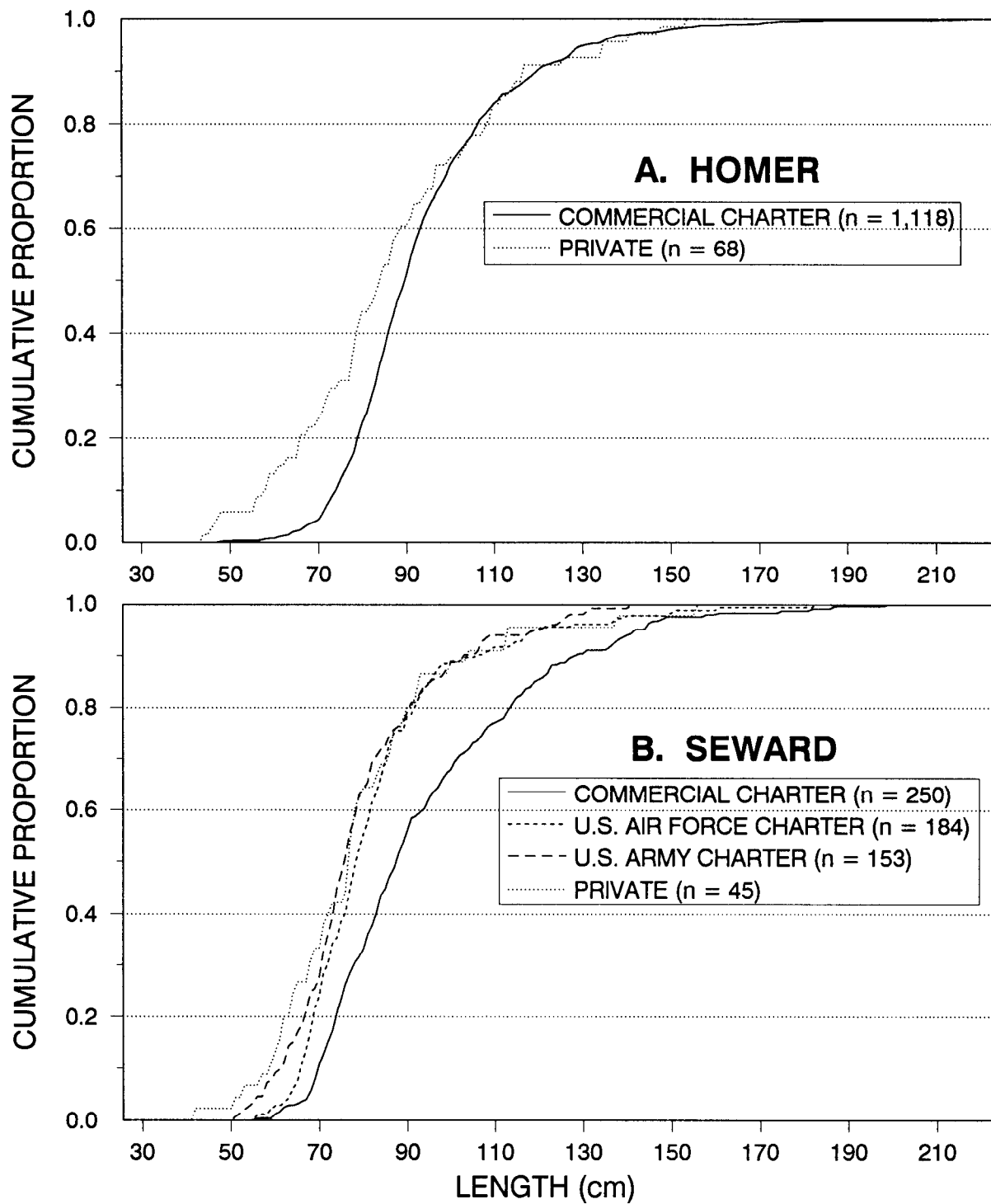
Figure 8. Comparisons of cumulative length-frequency distributions of halibut harvested in 1992: (a) by chartered and private (non-chartered) anglers at Homer, and (b) by commercial charter, military charter, and non-chartered anglers at Seward.

Table 4. Weighted mean length-at-age of male and female halibut harvested at Kodiak, Homer, Seward, and Valdez by the sport fishery in July 1992.

| | Males | | Females | |
Age	Mean (cm)	SE(Mean)	Mean (cm)	SE(Mean)
4				
5			63.5	2.8
6	71.1	1.7	72.5	2.6
7	76.7	4.4	80.3	1.4
8	73.8	0.8	88.7	1.4
9	77.5	1.3	96.8	1.3
10	84.0	4.3	105.9	3.7
11	87.4	5.4	116.7	3.9
12	85.4	3.2	137.8	5.7
13			135.7	6.6
14	89.0	6.8	151.9	1.1
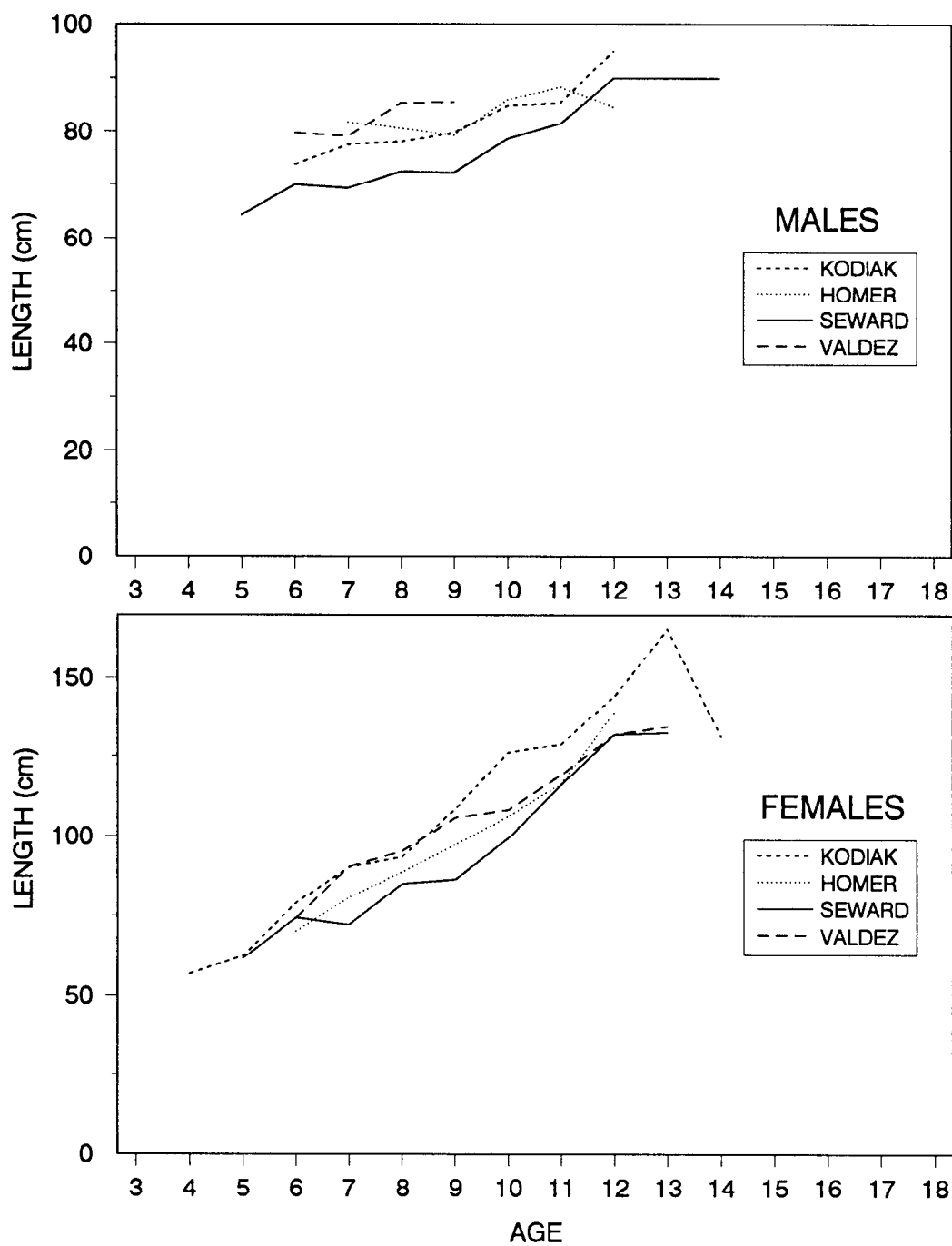
Figure 9. Mean length at age of male (top) and female (bottom) halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in July 1992 (Appendix B3).

most ages. Because only about 150 fish from July were aged at each port, some differences may have been due to inadequate sample sizes. Further evidence for differences in size include the fact that fish harvested at Kodiak were larger than at Homer (Table 3), but Homer halibut were slightly older (Figure 6).

Sex Composition

Female halibut dominated the sport harvest at all ports in all months (Figure 10; Appendix B3). Over the season, the percentage of females ranged from 63% at Seward to 85% at Kodiak. Differences between ports were highly significant ($\chi^2 = 183.435$, $P < 0.001$, df = 3), mostly due to the relatively low proportion of females at Seward. Differences between the other three ports were marginally significant ($\chi^2 = 5.805$, $P = 0.055$, df = 2). Differences among months in sex ratio were significant at Kodiak ($\chi^2 = 14.722$, $P = 0.001$, df = 2) and Seward ($\chi^2 = 10.156$, $P = 0.038$, df = 4), but not at Homer ($\chi^2 = 3.258$, $P = 0.516$, df = 4) or Valdez ($\chi^2 = .326$, $P = 0.850$, df = 2).

Computerized data files used to generate these analyses are listed in Appendix D.

DISCUSSION AND RECOMMENDATIONS

Strong seasonal trends were observed in age and size of halibut harvested at Homer and Valdez in 1991 (Meyer 1992). Fish taken in July were significantly older and larger than fish taken in May or September, possibly because of seasonal movements between spawning and feeding grounds (Calvin Blood, IPHC, personal communication). These trends were again evident at Homer and Valdez but were weaker; only fish harvested in September were appreciably smaller (Figure 7). Larger halibut may have already been near shore and available to the sport fishery by the time the fishery commenced in early 1992.

Most of the observed differences in size composition between ports correspond with differences in sex ratio, because female halibut are considerably larger at age and reach a greater size than males. The mean length of harvested halibut was highest at Kodiak, the port with the highest proportion of females (Table 3). Conversely, fish harvested at Seward were much smaller and the proportion of females was significantly lower. Observed differences in size and sex composition in the harvest could be due to real geographical differences in parameters or selection by the fishery for certain size or sex. Selection by the fishery could happen through spatial segregation of sexes and effort or through selective retention of certain sizes of fish. Differences in size composition could also be due to geographical differences in length-at-age for both sexes. For example, males and females at Seward appeared to be considerably smaller at age than at other ports (Figure 9; Appendix B1). Age composition at Seward, however, was functionally similar to Kodiak and Valdez, ports with higher mean lengths. The differences in length composition, sex composition, and size at age indicate a possibility that there are localized substocks along the Southcentral Alaska coast. Future sample sizes should be increased to allow comparison of growth parameters between areas.

It was noted that chartered anglers harvested larger fish than private anglers at Homer and Seward. At Homer, chartered anglers simply harvested relatively
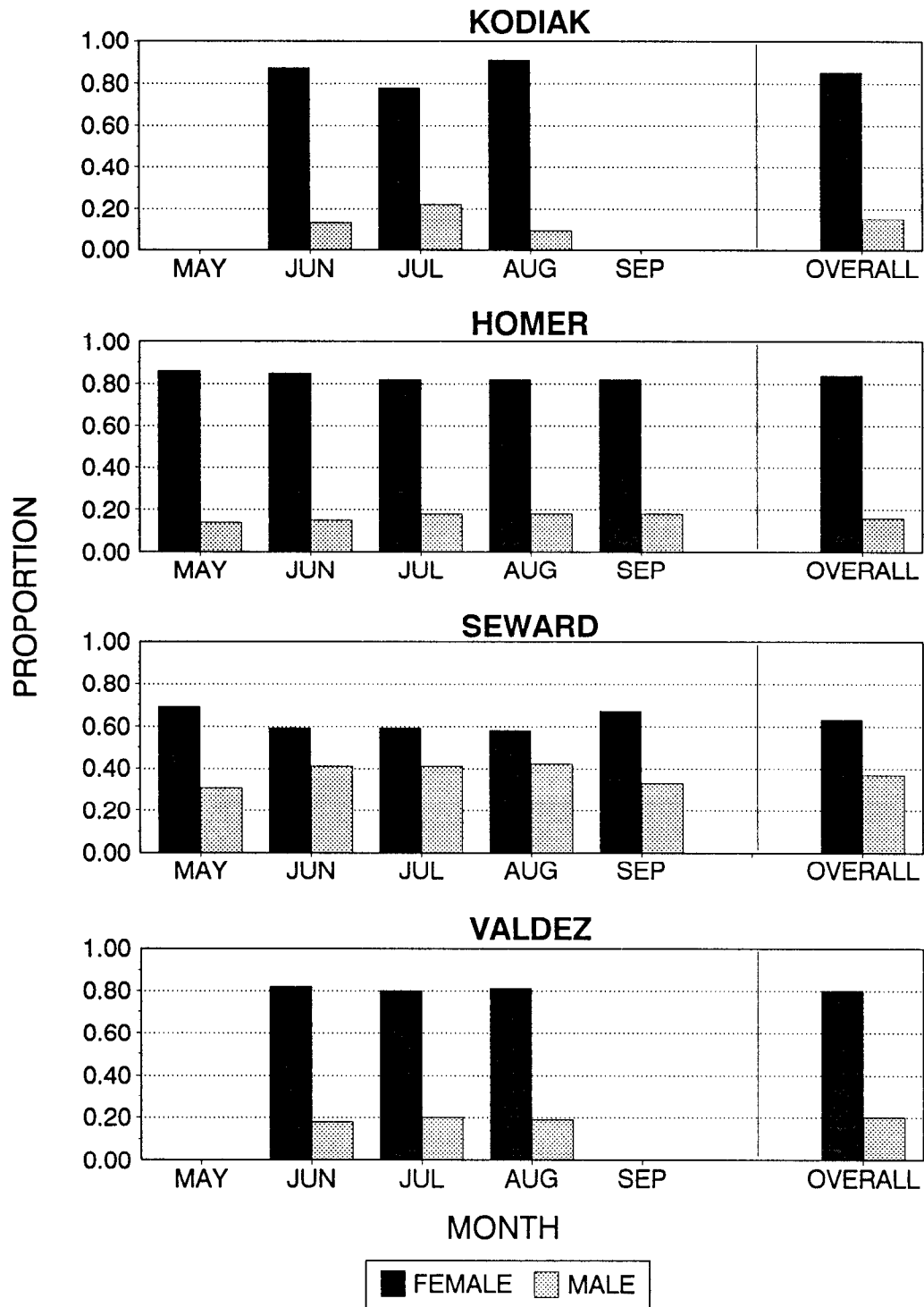
Figure 10. Relative proportions of male and female halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

fewer small fish. At Seward, chartered anglers harvested fewer small fish and more large fish (Figure 8). Possible explanations may include differences in the sizes of fish caught, or differential retention of small fish by the two groups. Differences observed at Seward were likely related to differences in boat size and areas fished. Private and U.S Army charter boats tend to be smaller and cannot fish as far from port as the larger public charter boats. Regardless of the reasons, the observed differences underscore the need to continue sampling both groups proportionately to avoid bias.

Catch at age data from 1991 (Meyer 1992) and 1992 show that recruitment to the sport fishery was complete by age 8 or 9 compared with age 11 for commercial harvest in Area 3A (Blood 1992). This difference is due primarily to the minimum size limit of 32 inches (81.3 cm) placed on the commercial fishery. Some groups have argued that a minimum size limit should be established for the recreational halibut fishery as well. The proportions of halibut harvested in the 1992 sport fishery that were under 32 inches ranged from 28% at Kodiak to 53% at Seward (Table 5). One potential drawback of a minimum size limit for the sport fishery would be that high catch rates could allow anglers to achieve their daily bag limit of larger fish, thus increasing the total weight of the harvest. This seems plausible given that the sport catch is much higher than the harvest.

The current minimum size limit may be reduced for other reasons. The IPHC has collected data that show size at age has decreased since institution of the size limit. This has resulted in a greater age at entry in the commercial harvest, particularly for males. In addition, the longline fishery is selective for males. These factors have prompted the IPHC to examine the effects of a reduction in the minimum size limit (Clark and Parma 1992).

Two types of inferences can be made from sport harvest data. The first concerns harvest. For example, these data probably accurately represent the age, size, and sex composition of the recreational harvest. The second involves population dynamics. For example, relative changes in age or size composition, mean length-at-age, etc. over time or area may reflect annual or seasonal trends in the population. Population inferences must take into consideration the selectivity of the sport fishery. The selectivity of the sport fishery could be put to good use by using catch-at-age information as an index of recruitment. Halibut begin to recruit to the sport fishery in significant numbers at about age 5 or 6, as opposed to age 8. These data could provide managers with 2 or 3 years advance notice of changes in relative year class strength.

The IPHC estimated the 1991 sport halibut harvest in Area 3A at 3.75 million pounds (net weight), but this number may be low. Applying mean weights estimated from 1991 data to the estimated number of fish harvested (Appendix A2; Mills 1992) resulted in a removal estimate of 4.27 million pounds (Appendix C). It also appeared that mean weights decreased significantly from 1991 to 1992 at Homer and Seward. This is consistent with decreasing biomass of adult fish, the increasing recruitment in recent years (Sullivan 1992), and a general decrease in size at age (Clark and Parma 1992).

The IPHC intends to incorporate age, size, and sex composition as well as catch rate data from the sport fishery into their stock assessment models. Continuous sampling of the sport halibut fishery by the ADF&G is planned, and

Table 5. Estimated proportion of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992 that were less than 32 inches (81.3 cm) in length.

Port	Number in Sample Under 32 Inches	Number of Fish Measured	Percent Under 32 Inches	SE(%)
Kodiak	186	662	28.1	1.75
Homer	472	1,673	28.2	1.10
Seward	526	999	52.7	1.58
Valdez	303	969	31.2	1.49

this project already collects all but the catch rate data. Logbooks could be used to gather catch rate information. The IPHC instituted a voluntary logbook program for charter boats in 1983 but found that participation was highest among the most successful charters (C. Blood, IPHC, personal communication). The Alaska Board of Fisheries rejected a proposal in November of 1992 that would have required logbooks on all charter boats in Cook Inlet. The sampling design of this study could be modified to obtain catch rate data, but the catch rate from the sport fishery may perform poorly as an index of abundance. Catch rates may not be representative of abundance because of changes in the availability of halibut due to seasonal movements. As noted above, data from 1991 and 1992 showed that seasonal changes in age and size composition vary from year to year. In addition, catch rates may not reflect changes in abundance if halibut exhibit fidelity to certain locations or habitats. In this scenario, anglers simply maintain catch rates by moving to lightly fished or unfished areas. The geographic differences in length, sex ratio, and size at age noted above suggest that there may be substocks subject to varying rates of exploitation.

ACKNOWLEDGEMENTS

LITERATURE CITED

Blood, C. L. 1992. Age composition and size at age of the commercial fishery for 1991. Pages 93-98 *in* Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.

Carlon, J. and D. Vincent-Lang. 1989. Sport efforts for and harvests of coho salmon and chinook salmon, halibut, and lingcod in Resurrection Bay sport fisheries, Alaska, during 1988. Alaska Department of Fish and Game, Fishery Data Series No. 83, Juneau.

LITERATURE CITED (Continued)

_____. 1990. Sport effort for and harvest of coho salmon, halibut, rockfish, and lingcod in Resurrection Bay sport fisheries, Alaska, during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-6, Anchorage.

Chilton, D. E. and R. J. Beamish. 1982. Age determination methods for fishes studied by the groundfish program at the Pacific Biological Station. Canadian Special Publication of Fisheries and Aquatic Sciences No. 60. Department of Fisheries and Oceans, Resource Services Branch, Pacific Biological Station, Nanaimo, B.C.

Clark, W. G. 1992. Validation of the IPHC length-weight relationship for halibut. Pages 113-116 *in* Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.

Clark, W. G. and A. M. Parma. 1992. Re-examination of halibut growth and the size limit. Pages 117-124 *in* Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.

Cochran, W. G. 1977. Sampling techniques (third edition). John Wiley and Sons, New York.

Conover, W. J. 1980. Practical nonparametric statistics. John Wiley and Sons, New York.

IPHC (International Pacific Halibut Commission). 1987. The Pacific halibut: biology, fishery, and management. Technical Report No. 22. International Pacific Halibut Commission, Seattle, WA.

Jones & Stokes Associates, Inc. 1987. Southcentral Alaska sport fishing economic study. Final research report. November 1987. (JSA86-0413.) Sacramento, CA. Prepared for Alaska Department of Fish and Game, Sport Fish Division, Research and Technical Services Section, Anchorage, AK.

Meyer, S. C. 1992. Biological characteristics of the sport harvest of marine groundfishes in Southcentral Alaska, 1991. Alaska Department of Fish and Game, Fishery Data Series No. 92-41, Anchorage.

Mills, M. J. 1979. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1978-1979, Project F-9-11, 20 (SW-1-A), Juneau.

_____. 1980. Alaska statewide sport fish harvest studies. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1979-1980, Project F-9-12, 21 (SW-1-A), Juneau.

_____. 1981a. Alaska statewide sport fish harvest studies (1979). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

LITERATURE CITED (Continued)

_____. 1981b. Alaska statewide sport fish harvest studies (1980). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1980-1981, Project F-9-13, 22 (SW-I-A), Juneau.

_____. 1982. Alaska statewide sport fish harvest studies (1981). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1981-1982, Project F-9-14, 23 (SW-1-A), Juneau.

_____. 1983. Alaska statewide sport fish harvest studies (1982). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1982-1983, Project F-9-15, 24 (SW-1-A), Juneau.

_____. 1984. Alaska statewide sport fish harvest studies (1983). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1983-1984, Project F-9-16, 25 (SW-1-A), Juneau.

_____. 1985. Alaska statewide sport fish harvest studies (1984). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1984-1985, Project F-9-17, 26 (SW-1-A), Juneau.

_____. 1986. Alaska statewide sport fish harvest studies (1985). Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Performance Report, 1985-1986, Project F-10-1, 27 (RT-2), Juneau.

_____. 1987. Alaska statewide sport fisheries harvest report 1986. Alaska Department of Fish and Game, Fishery Data Series No. 2, Juneau.

_____. 1988. Alaska statewide sport fisheries harvest report 1987. Alaska Department of Fish and Game, Fishery Data Series No. 52, Juneau.

_____. 1989. Alaska statewide sport fisheries harvest report 1988. Alaska Department of Fish and Game, Fishery Data Series No. 122, Juneau.

_____. 1990. Harvest and participation in Alaska sport fisheries during 1989. Alaska Department of Fish and Game, Fishery Data Series No. 90-44, Anchorage.

_____. 1991. Harvest and participation in Alaska sport fisheries during 1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-58, Anchorage.

_____. 1992. Harvest and participation in Alaska sport fisheries during 1991. Alaska Department of Fish and Game. Fishery Data Series No. 92-40, Anchorage.

Nielsen, L. A. and W. F. Schoch. 1980. Errors in estimating mean weight and other statistics from mean length. Transactions of the American Fisheries Society 109:319-322.

Roth, K. J. and K. J. Delaney. 1989. Creel statistics for the Valdez Arm and Eshamy Bay sport fisheries of Prince William Sound, Alaska, during 1988. Alaska Department of Fish and Game, Fishery Data Series No. 103, Juneau.

LITERATURE CITED (Continued)

Scholz, F. W. and M. A. Stephens. 1987. K-sample Anderson-Darling test. Journal of the American Statistical Association 82:918-924.

Sullivan, P. J. 1992. Population assessment, 1991. Pages 41-51 *in* Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.

Sullivan, P. J., A. M. Parma, and B. A. Vienneau. 1992. Population assessment, 1991, technical supplement. Pages 53-69 *in* Report of assessment and research activities, 1991. International Pacific Halibut Commission, Seattle, Washington.

Thompson, S. K. 1987. Sample size for estimating multinomial proportions. The American Statistician 41:42-46.

Vincent-Lang, D. 1991. Age, length, and species compositions of groundfish harvested in the marine sport fisheries of Resurrection Bay, Alaska, 1988-1990. Alaska Department of Fish and Game, Fishery Data Series No. 91-28, Anchorage.

Vincent-Lang, D., R. H. Conrad, and E. T. McHenry. 1988. Sport harvests of coho *Oncorhynchus kisutch* and chinook *O. tshawytscha* salmon in Resurrection Bay, Alaska during 1987. Alaska Department of Fish and Game, Fishery Data Series No. 39, Juneau.

APPENDIX A

Historical Effort and Harvest Estimates

Appendix A1. Estimated angler effort, by region, for saltwater finfish in Southcentral Alaska (IPHC Regulatory Area 3A), 1979-1991 (Mills 1981a-1992).

	Estimated Effort in Angler-Days							Percent of Statewide From Area 3A
Year	Kodiak[a]	Cook Inlet[b]	Seward[c]	PWS[d]	Yakutat[e]	Total Area 3A[f]	Statewide	
1979	23,124	102,383	43,576	33,939	911	203,933	387,558	52.6
1980	27,646	90,864	49,623	31,317	985	200,435	404,681	49.5
1981	29,857	96,755	56,410	33,669	1,505	218,196	435,933	50.1
1982	41,113	95,622	49,167	30,826	2,371	219,099	467,380	46.9
1983	40,217	159,912	40,144	36,063	3,524	279,860	543,383	51.5
1984	34,213	142,255	44,669	40,670	2,540	264,347	554,712	47.7
1985	33,032	132,765	47,472	66,291	1,193	280,753	565,119	49.7
1986	31,762	149,417	51,375	51,681	1,303	285,538	578,027	49.4
1987	38,671	192,203	42,143	69,425	4,953	347,395	650,120	53.4
1988	30,522	190,409	50,251	78,367	2,494	352,043	675,479	52.1
1989	35,485	170,536	47,386	80,119	1,470	334,996	708,028	47.3
1990	34,969	226,648	69,485	98,000	2,030	431,132	824,190	52.3
1991	42,315	214,157	71,332	102,927	5,142	435,873	829,161	52.6

[a] Kodiak: marine waters surrounding the Kodiak and Afognak Island groups, including the Barren and Trinity Islands.

[b] Cook Inlet: includes all waters north of a line roughly from Gore Point to Cape Douglas.

[c] Seward: includes waters of Resurrection Bay and the southern coast of the Kenai Peninsula.

[d] Prince William Sound: includes all waters between Cape Suckling and Cape Puget.

[e] Yakutat: Yakutat Bay and adjacent Gulf of Alaska waters.

[f] IPHC Regulatory Area 3A includes all waters from Cape Spencer to the southern end of Kodiak Island (Cape Trinity).

Appendix A2. Estimated sport harvest, by region, of halibut in IPHC Area 3A, 1977-1991 (Mills 1979-1992).

| | | Number of Fish Harvested by Location | | | | | | |
Year	Kodiak[a]	Cook Inlet[b]	Seward[c]	PWS[d]	Yakutat[e]	Total Area 3A[f]	Statewide	Percent of Statewide From Area 3A
1977	994	13,497	1,674	1,247	428	17,840	23,244	76.8
1978	1,721	25,658	2,642	933	24	30,978	37,085	83.5
1979	3,013	27,061	2,838	1,691	78	34,681	47,705	72.7
1980	3,651	30,066	2,936	3,143	34	39,830	64,658	61.6
1981	6,858	38,827	3,337	2,495	65	51,582	74,212	69.5
1982	9,180	39,677	2,809	2,735	398	54,799	92,358	59.3
1983	8,545	60,520	2,225	3,493	682	75,465	117,042	64.5
1984	8,179	61,227	3,242	4,428	241	77,317	124,970	61.9
1985	7,303	63,606	5,486	4,527	520	81,442	127,634	63.8
1986	10,960	85,903	9,648	8,331	777	115,619	160,885	71.9
1987	9,869	77,741	6,520	4,379	1,194	99,703	145,829	68.4
1988	7,749	137,525	11,423	9,845	1,673	168,215	225,106	74.7
1989	10,435	127,316	6,852	8,697	772	154,072	229,016	67.3
1990	9,134	148,760	9,278	10,851	1,459	179,482	247,202	72.6
1991	12,089	149,503	12,961	12,733	2,112	189,398	266,523	71.1

[a] Kodiak: marine waters surrounding the Kodiak and Afognak Island groups, including the Barren and Trinity Islands.

[b] Cook Inlet: includes all waters north of a line roughly from Gore Point to Cape Douglas.

[c] Seward: includes waters of Resurrection Bay and the southern coast of the Kenai Peninsula.

[d] Prince William Sound: includes all waters between Cape Suckling and Cape Puget.

[e] Yakutat: Yakutat Bay and adjacent Gulf of Alaska waters.

[f] IPHC Regulatory Area 3A includes all waters from Cape Spencer to the southern end of Kodiak Island (Cape Trinity).

APPENDIX B

Halibut Age, Length, and Sex Composition

Appendix B1. Observed frequencies and proportions, by age class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

Age	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
4			6	6		12			0.041	0.034	0.333	0.025	0.007
5		8	16	13	1	38		0.053	0.108	0.073		0.079	0.012
6		4	9	10		23		0.027	0.061	0.056		0.048	0.010
7		20	16	25		61		0.133	0.108	0.140		0.128	0.015
8		44	33	40		117		0.293	0.223	0.225		0.246	0.020
9		30	22	34	1	87		0.200	0.149	0.191	0.333	0.181	0.018
10		15	10	19		44		0.100	0.068	0.107		0.092	0.013
11		13	19	8	1	41		0.087	0.128	0.045	0.333	0.084	0.013
12		5	8	7		20		0.033	0.054	0.039		0.042	0.009
13		6	4	6		16		0.040	0.027	0.034		0.034	0.008
14		1	2	4		7		0.007	0.014	0.022		0.015	0.006
15		4	2	2		8		0.027	0.014	0.011		0.017	0.006
16				3		3				0.017		0.006	0.004
17			1	1		2			0.007	0.006		0.004	0.003
	0	150	148	178	3	479		1.000	1.000	1.000	1.000	1.000	
HOMER:													
4	1		1		8	10	0.006		0.007		0.057	0.013	0.004
5	1	1	1	1	11	15	0.006	0.006	0.007	0.006	0.079	0.020	0.005
6	10	6	3	20	12	51	0.065	0.037	0.020	0.129	0.086	0.067	0.009
7	15	12	15	20	26	88	0.097	0.075	0.101	0.129	0.186	0.116	0.012
8	25	32	27	47	22	153	0.161	0.199	0.181	0.303	0.157	0.201	0.015
9	39	46	53	40	27	205	0.252	0.286	0.356	0.258	0.193	0.270	0.016
10	24	22	18	10	12	86	0.155	0.137	0.121	0.065	0.086	0.113	0.011
11	16	21	18	6	10	71	0.103	0.130	0.121	0.039	0.071	0.093	0.011
12	7	8	9	8	8	40	0.045	0.050	0.060	0.052	0.057	0.053	0.008
13	7	8	2		2	19	0.045	0.050	0.013		0.014	0.025	0.006
14	2	4	1	1	1	9	0.013	0.025	0.007	0.006	0.007	0.012	0.004
15	4	1			1	6	0.026	0.006			0.007	0.008	0.003
16	3			1		4	0.019			0.006		0.005	0.003
17			1			1			0.007			0.001	0.001
18													
19				1		1				0.006		0.001	0.001
20													
21													
22	1					1	0.006					0.001	0.001
	155	161	149	155	140	760	1.000	1.000	1.000	1.000	1.000	1.000	

Appendix B1. (Page 2 of 2).

	Number of Fish						Proportions						
Age	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
3	1			1		2	0.007			0.008		0.003	0.002
4	1	1	2	2	1	7	0.007	0.006	0.013	0.016	0.019	0.011	0.004
5	6	2	8	2	2	20	0.039	0.013	0.054	0.016	0.038	0.031	0.007
6	12	13	17	14	3	59	0.078	0.082	0.114	0.112	0.058	0.092	0.011
7	26	22	21	32	10	111	0.170	0.138	0.141	0.256	0.192	0.174	0.015
8	34	32	38	19	7	130	0.222	0.201	0.255	0.152	0.135	0.204	0.016
9	23	34	26	24	15	122	0.150	0.214	0.174	0.192	0.288	0.191	0.016
10	14	16	15	10	6	61	0.092	0.101	0.101	0.080	0.115	0.096	0.012
11	17	16	8	11	6	58	0.111	0.101	0.054	0.088	0.115	0.091	0.011
12	13	9	5	6	1	34	0.085	0.057	0.034	0.048	0.019	0.053	0.009
13	5	4	5	1		15	0.033	0.025	0.034	0.008		0.024	0.006
14	1	6	2	3	1	13	0.007	0.038	0.013	0.024	0.019	0.020	0.006
15		1	1			2		0.006	0.007			0.003	0.002
16		2	1			3		0.013	0.007			0.005	0.003
17		1				1		0.006				0.002	0.002
	153	159	149	125	52	638	1.000	1.000	1.000	1.000	1.000	1.000	
VALDEZ:													
3				1		1				0.007		0.002	0.002
4		5	1	3		9		0.030	0.007	0.020		0.019	0.006
5		8	3	6		17		0.047	0.021	0.041		0.037	0.009
6		25	10	18		53		0.148	0.068	0.122		0.114	0.015
7		34	29	25		88		0.201	0.199	0.169		0.190	0.018
8		25	39	40		104		0.148	0.267	0.270		0.225	0.019
9		25	22	23		70		0.148	0.151	0.155		0.151	0.017
10		19	17	11		47		0.112	0.116	0.074		0.102	0.014
11		14	11	5		30		0.083	0.075	0.034		0.065	0.011
12		6	7	9		22		0.036	0.048	0.061		0.048	0.010
13		2	3	3		8		0.012	0.021	0.020		0.017	0.006
14		2	2	1		5		0.012	0.014	0.007		0.011	0.005
15		1				1		0.006				0.002	0.002
16		2	1			3		0.012	0.007			0.006	0.004
17		1	1	3		5		0.006	0.007	0.020		0.011	0.005
	0	169	146	148	0	463		1.000	1.000	1.000		1.000	

Appendix B2. Observed frequencies and proportions, by length class, of halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in 1992.

Length Class[a]	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
KODIAK:													
40		5	1	2	1	9		0.021	0.004	0.011	0.143	0.014	0.005
50		9	10	6		25		0.038	0.042	0.034		0.038	0.007
60		19	18	12	1	50		0.079	0.075	0.068	0.143	0.076	0.010
70		36	34	20		90		0.151	0.142	0.113		0.136	0.013
80		40	56	31	1	128		0.167	0.234	0.175	0.143	0.193	0.015
90		33	25	20	2	80		0.138	0.105	0.113	0.286	0.121	0.013
100		25	26	25		76		0.105	0.109	0.141		0.115	0.012
110		21	21	20		62		0.088	0.088	0.113		0.094	0.011
120		15	14	10		39		0.063	0.059	0.056		0.059	0.009
130		15	11	10		36		0.063	0.046	0.056		0.054	0.009
140		11	6	7	2	26		0.046	0.025	0.040	0.286	0.039	0.008
150		6	8	6		20		0.025	0.033	0.034		0.030	0.007
160		2	5	2		9		0.008	0.021	0.011		0.014	0.005
170		1	1	3		5		0.004	0.004	0.017		0.008	0.003
180		1	1	0		2		0.004	0.004	0.000		0.003	0.002
190			1	2		3			0.004	0.011		0.005	0.003
200			1	1		2			0.004	0.006		0.003	0.002
	0	239	239	177	7	662		1.000	1.000	1.000	1.000	1.000	
HOMER:													
40	1	2			5	8	0.004	0.003			0.035	0.005	0.002
50	2	1	3	3	6	15	0.008	0.002	0.010	0.009	0.043	0.009	0.002
60	17	34	4	12	14	81	0.066	0.051	0.014	0.037	0.099	0.048	0.005
70	54	125	42	68	31	320	0.210	0.189	0.145	0.211	0.220	0.191	0.010
80	61	177	71	104	41	454	0.237	0.267	0.245	0.322	0.291	0.271	0.011
90	60	122	76	71	17	346	0.233	0.184	0.262	0.220	0.121	0.207	0.010
100	27	77	44	34	9	191	0.105	0.116	0.152	0.105	0.064	0.114	0.008
110	13	47	18	15	7	100	0.051	0.071	0.062	0.046	0.050	0.060	0.006
120	7	33	15	10	4	69	0.027	0.050	0.052	0.031	0.028	0.041	0.005
130	5	16	6	3	4	34	0.019	0.024	0.021	0.009	0.028	0.020	0.003
140	3	12	4			19	0.012	0.018	0.014			0.011	0.003
150	3	8	3		1	15	0.012	0.012	0.010		0.007	0.009	0.002
160	1	1		1	2	5	0.004	0.002		0.003	0.014	0.003	0.001
170		3	2	1		6		0.005	0.007	0.003		0.004	0.001
180	1	2	2			5	0.004	0.003	0.007			0.003	0.001
190	1					1	0.004					0.001	0.001
200	1					1	0.004					0.001	0.001
210		2		1		3		0.003		0.003		0.002	0.001
	257	662	290	323	141	1673	1.000	1.000	1.000	1.000	1.000	1.000	

-continued-

Length Class[a]	Number of Fish						Proportions						
	May	Jun	Jul	Aug	Sep	Total	May	Jun	Jul	Aug	Sep	Total	SE(Total)
SEWARD:													
40	3					3	0.010					0.003	0.002
50	15	13	7	5	3	43	0.049	0.052	0.027	0.040	0.059	0.043	0.006
60	55	40	46	26	3	170	0.179	0.159	0.174	0.210	0.059	0.170	0.012
70	65	72	86	36	20	279	0.211	0.286	0.326	0.290	0.392	0.279	0.014
80	53	59	56	22	15	205	0.172	0.234	0.212	0.177	0.294	0.205	0.013
90	34	26	27	12	3	102	0.110	0.103	0.102	0.097	0.059	0.102	0.010
100	34	15	13	7	2	71	0.110	0.060	0.049	0.056	0.039	0.071	0.008
110	19	14	7	6	2	48	0.062	0.056	0.027	0.048	0.039	0.048	0.007
120	8	5	7	4	1	25	0.026	0.020	0.027	0.032	0.020	0.025	0.005
130	10	4	4	2	1	21	0.032	0.016	0.015	0.016	0.020	0.021	0.005
140	7	3	7	3	1	21	0.023	0.012	0.027	0.024	0.020	0.021	0.005
150			3			3			0.011			0.003	0.002
160	2	1				3	0.006	0.004				0.003	0.002
170	1					1	0.003					0.001	0.001
180	2		1			3	0.006		0.004			0.003	0.002
190				1		1				0.008		0.001	0.001
	308	252	264	124	51	999	1.000	1.000	1.000	1.000	1.000	1.000	
VALDEZ:													
30		1	1		1	3		0.002	0.005		0.032	0.003	0.002
40		2	1			3		0.004	0.005			0.003	0.002
50		36	5	11	3	55		0.075	0.023	0.046	0.097	0.057	0.007
60		46	8	19	6	79		0.096	0.036	0.080	0.194	0.082	0.009
70		55	38	38	4	135		0.115	0.172	0.160	0.129	0.139	0.011
80		87	48	58	5	198		0.182	0.217	0.244	0.161	0.204	0.013
90		65	44	32	5	146		0.136	0.199	0.134	0.161	0.151	0.011
100		50	26	28	1	105		0.104	0.118	0.118	0.032	0.108	0.010
110		45	19	16	3	83		0.094	0.086	0.067	0.097	0.086	0.009
120		28	13	14		55		0.058	0.059	0.059		0.057	0.007
130		26	9	5	2	42		0.054	0.041	0.021	0.065	0.043	0.007
140		14	4	6		24		0.029	0.018	0.025		0.025	0.005
150		7	5	5		17		0.015	0.023	0.021		0.018	0.004
160		3		3	1	7		0.006		0.013	0.032	0.007	0.003
170		8		1		9		0.017		0.004		0.009	0.003
180		3				3		0.006				0.003	0.002
190		2		1		3		0.004		0.004		0.003	0.002
200													0.000
210		1		1		2		0.002		0.004		0.002	0.001
	0	479	221	238	31	969		1.000	1.000	1.000	1.000	1.000	

[a] Lower limits of 10 cm length classes (e.g. 40 = 40.0 cm-49.9 cm)

Appendix B3. Mean length-at-age (cm) of male and female halibut harvested by sport anglers at Kodiak, Homer, Seward, and Valdez in July 1992.

AGE	Kodiak			Homer			Seward			Valdez		
	n	Mean	SE(Mean)	n	Mean	SE(Mean)	n	Mean	SE(Mean)	n	Mean	SE(Mean)
Males:												
4	1	54.6					1	54.5		1	6.6	
5	1	73.0		1	58.5		2	64.3	4.75	1	5.2	
6	2	73.8	4.75	1	70.5		6	70.0	3.33	3	79.7	1.48
7	4	77.5	3.08	2	81.8	9.75	8	69.3	1.09	11	79.0	2.82
8	8	78.1	2.04	1	71.5		14	72.5	0.96	7	85.4	5.01
9	6	79.7	2.67	9	79.3	1.49	8	72.3	2.41	2	85.5	9.00
10	4	84.9	1.79	5	85.9	5.89	9	78.6	1.93			
11	6	85.4	2.34	4	88.3	6.30	3	81.5	1.61			
12	3	95.1	2.79	3	84.6	3.63	2	90.0	6.50			
13				1	112.5		1	136.5				
14							2	90.0	8.00	1	83.0	
15	1	109.3										
16							1	133.5		1	137.5	
17										1	143.0	
	36			27			57			28		
Females:												
4	4	56.9	2.85	1	56.0		1	66.5				
5	11	62.3	1.04				4	61.6	3.82	1	87.0	
6	7	79.1	2.83	2	70.3	4.75	10	74.4	2.68	4	74.3	6.81
7	12	90.3	3.96	12	80.8	1.68	13	72.3	1.87	15	90.4	3.81
8	25	93.5	2.39	24	88.7	1.71	22	85.1	2.17	28	95.3	1.70
9	15	108.5	3.77	39	97.3	1.43	17	86.5	2.30	17	105.7	3.23
10	5	126.2	4.92	13	106.2	4.28	5	99.5	7.89	15	108.1	4.59
11	13	128.8	4.62	14	116.4	4.37	5	116.1	8.36	10	119.1	6.74
12	5	144.1	6.55	4	138.9	6.91	3	132.0	6.33	4	131.9	2.79
13	4	165.5	7.80				3	132.5	9.44	3	134.3	7.16
14	2	131.2	3.73	1	153.0					1	145.0	
15	1	169.7					1	182.0				
16												
17	1	206.3		1	186.0							
	105			111			84			98		

Appendix B4. Observed frequencies and proportions of female halibut harvested by sport anglers each month at Kodiak, Homer, Seward, and Valdez in 1992.

Port	Month	Number of Fish			Proportion Females[a]	
		Female	Male	Unknown	p	SE(p)
Kodiak	Jun	206	32	3	0.866	0.022
	Jul	181	52	11	0.777	0.027
	Aug	147	14	21	0.913	0.022
	Sep	7	0	0	1.000	0.000
	Total	541	98	35	0.847	0.014
Homer	May	206	33	21	0.862	0.022
	Jun	540	98	39	0.846	0.014
	Jul	228	51	14	0.817	0.023
	Aug	250	54	19	0.822	0.022
	Sep	111	25	5	0.816	0.033
	Total	1,335	261	98	0.836	0.009
Seward	May	205	90	17	0.695	0.027
	Jun	149	102	5	0.594	0.031
	Jul	152	105	14	0.591	0.031
	Aug	68	50	8	0.576	0.045
	Sep	35	17	1	0.673	0.065
	Total	609	364	45	0.626	0.016
Valdez	Jun	275	61	152	0.818	0.021
	Jul	167	42	20	0.799	0.028
	Aug	185	44	13	0.808	0.026
	Sep	14	9	9	0.609	0.102
	Total	641	156	194	0.804	0.014

[a] The proportion of females was computed using only fish of known sex.

APPENDIX C

Estimation of Sport Harvest Biomass for 1991

Appendix C. Estimation of the sport harvest biomass in Area 3A in 1991.

Step 1. Estimated mean net weights (pounds) of sport-caught halibut by
        location, 1991.

Location	Estimated Mean Weight	SE(Mean)
Deep Creek	21.970	0.928
Homer	22.450	1.080
Seward	20.680	1.060
Valdez	22.984	0.585
Kodiak	27.110[a]	1.110[a]

[a] No data were available to estimate the mean weight for Kodiak in 1991.
Therefore, the 1992 estimated mean weight was substituted.

Step 2. Estimated biomass of sport removals in Area 3A using estimated
        harvest (Mills 1992) and mean weights.

Area	Harvest (Number)	Mean Net Weight	Harvest (Pounds)
Yakutat	2,112	22.984	48,542
Prince William Sound	12,733	22.984	292,655
West Cook Inlet	1,576	21.970	34,625
Deep Creek	34,867	21.970	766,028
Whiskey Gulch	5,327	21.970	117,034
Ninilchik	1,304	21.970	28,649
Homer, other	106,429	22.450	2,389,331
Resurrection Bay	12,961	20.680	268,033
Kodiak	12,089	27.110	327,733
			4,272,630

APPENDIX D

List of Data Filenames and Contents

Appendix D. Names and contents of ASCII computer files containing 1992 halibut raw data. All files are in Mark Sense Biological (AWL, Version 1.1) format.

Location	Filename (*.DTA)	Inclusive Dates	Page Numbers
Kodiak	Q7540BB2	Jun 5 - Sep 8	001-064
Homer	10030BB2	May 22 - Sep 11	001-095
Seward	10020BC2	May 17 - Sep 13	001-081
Valdez	J0010BB2	Jun 1 - Sep 7	001-068